AMENDMENTS TO THE DRAWINGS

The attached sheets of drawings include changes to Figures 23 through 28 .

Attachment: Replacement sheets

REMARKS

Claims 1-5 and 8-13 are now pending in the application. Claims 6 and 7 are withdrawn. The amendments to the claims contained herein are of equivalent scope as originally filed and, thus, are not a narrowing amendment. The Examiner is respectfully requested to reconsider and withdraw the rejections in view of the amendments and remarks contained herein.

DRAWINGS

The drawings stand objected to for certain informalities. Applicant has attached revised drawings for the Examiner's approval. In the "Replacement Sheets", Figures 23 through 28 have been designated with the legend -- Prior Art --, at the Examiner's suggestion.

REJECTIONS UNDER 35 U.S.C. § 102 AND §103

Claims 1, 2, 4, 5, 8 and 10 stand rejected under 35 U.S.C. § 102(b) as being anticipated by Sulavuori et al. (U.S. Pat. No. 5,636,264). Claims 3, 9 and 11-13 stand rejected under 35 U.S.C. §103 over Sulavuori et al in combination with other art. These rejections are respectfully traversed. As will be more fully explained below, applicants' invention employs a unique technique not employed in the art of record.

Applicants' invention employs noise shaping with return-to-zero (RZ) signals

A major feature of the invention as recited in independent claims 1 and 2 is that a noise shaping method is combined with the use of return-to-zero (RZ) signals, which provides the advantage of reducing jitter. In contrast, Sulavuori does not disclose or suggest the feature of the invention as recited in claims 1 and 2. Indeed, Sulavuori is unaware of reducing jitter as a problem to be solved.

It appears that the Examiner considers that a continuously variable slope delta modulation (CVSD) of Sulavuori corresponds to the noise shaping method recited in claims 1 and 2 (page 3, line 5 of the office action). However, the CVSD is fundamentally different from applicants' noise shaping method, as will be next demonstrated. Please refer to the accompanying "Reference Diagrams" which compare the Sulavuori technique with Applicants' technique.

In the set of included Reference Diagrams, Diagram 1 is included for background understanding of how conventional transmission using PCM-A/D conversion is accomplished and is believed to be self-explanatory. The Sulavuori technique is introduced beginning with Reference Diagram 3; applicants' noise-shaping technique is introduced beginning with Reference Diagram 9.

<u>**The CVSD technique of Sulavuori**</u>

Reference Diagram 3 shows delta A/D conversion on which CVSD scheme disclosed in Sulavuori is based (for example, column 4, lines 6-12, column 4, lines 53-67 and column 5 lines 1-17, and column 7, lines 28-39, of Sulavuori).

At a transmitter, in order to convert the voltage of an input signal at point B, the input signal is differentiated to obtain the difference between the voltage at point A and the voltage at point B, the difference voltage is converted into k-bit binary data, the converted binary data is further converted into a serial data stream, and the resultant stream is transmitted. At a receiver, an original k-bit signal is restored from a serial data stream received, and the restored k-bit signal is added to data corresponding to the voltage at point A which has already been obtained to reproduce data corresponding to the voltage at point B.

Unlike the conventional transmission using PCM-A/D conversion, transmission using delta A/D conversion allows reproducing data from the transmitter precisely by setting a sampling rate to a sufficiently high value as compared with the signal band,

even if k is set to one. In this case, unlike the conventional transmission using PCM-A/D conversion in which each group contains a plurality of pieces of bit data that causes the aforementioned problem, each group contains one bit data, so that it is not necessary to detect the head and tail of data in each group. Thus, data corresponding to an original signal can be obtained by adding current data to an integrated value of a plurality of pieces of data that have been already transmitted by that time.

As shown in Reference Diagram 4, it is not necessary for the delta A/D conversion to provide the parallel-to-serial converter and the frame processor at the transmitter shown in Reference Diagram 2 and the frame processor and the serial-to-parallel converter at the transmitter shown in Reference Diagram 2.

However, because of the characteristics of the employed conversion technique, the delta A/D conversion <u>requires an integrator</u> at the receiver that integrates received data in order to reproduce data corresponding to an original signal. In other words, the delta A/D conversion cannot reproduce the original signal unless such an integrator is installed.

In addition, integrators have theoretically an infinite amplification factor with respect to a DC offset. Thus, when a DC offset is present in received data, the integrators overflow or underflow and they cannot operate even if the offset is considerably small.

Here, the ground level at the receiver is determined by an average of signals of a low level and signals of a high level. Furthermore, a difference between this average and the middle of a low level and high level results in a DC offset.

In the delta A/D conversion, the frequency of occurrence of "1" contained in data is the same as that of "0" for a long period of time. Thus, if such data is transmitted and the duty ratio of a pulse is 100% as shown in Reference Diagram 5, the average is equal to the middle of a low level and a high level. As a result, the difference becomes

zero and signal waveforms having no DC offsets can be obtained. Integrators do not overflow even if such signal waveforms are input thereto.

However, as shown in Reference Diagram 6, Sulavuori narrows the width of pulses to be transmitted (see FIG. 1 of Sulavuori) by a pulse shaper at the transmitter (for example, reference numerals 105 and 210 shown in FIG. 4A and 4B), thereby resulting in a difference between the duration of a high level in a signal corresponding to logical value "1" and the duration of a low level in a signal corresponding to logical value "0". As a result, as shown in Reference Diagram 7, the average shifts from the middle of a high level and a low level to the low level side, thereby resulting in a DC offset. Therefore, upon receiving such a signal waveform, integrators underflow and cannot operate.

As shown below, there are two solutions to solve this problem.

(1) Instead of directly inputting a received signal into the integrator, a pulse expander provided in the receiver restores the duty ratio of a pulse of the received signal to 100% so as to cancel the DC offset, and the resultant pulse is input into the integrator.

(2) As shown in Reference Diagram 8, a DC feedback circuit comprised by a low pass filter having a small time constant is added to the integrator to set a DC amplification factor to one, thereby preventing overflow and underflow being generated.

However, the low pass filter used for the DC feedback circuit is implemented by a first-order RC circuit. Thus, in the solution (2), in order to obtain a sufficient amplification factor so as to allow the integrator operating at a 20Hz, which is the lowest frequency in the audible frequency band, it is necessary to set the cut-off frequency of the low pass filter to 0.02 Hz or below. Therefore, extremely large size elements must be provided for a capacitor C2 and a resistor R2 shown in Reference Diagram 8,

making it difficult to miniaturize the receiver. In addition, a resistor R1 and a capacitor C2 serve as a low pass filter, and thus the integrator cannot perform an integration operation.

As described above, it is indispensable for Sulavuori to provide the pulse expander in the receiver that expands the duty ratio of a pulse to 100%. In addition, it is necessary for this pulse expander to precisely restore the duty ratio of a pulse to 100%.

A/D Conversion using noise-shaping method of present invention

As shown in Reference Diagram 9, the structure of a noise-shaping A/D converter resembles the structure of a delta A/D converter shown in Reference Diagram 3. However, by providing an integrator in a loop at a transmitter, the noise-shaping A/D converter provides distinctive features which are quite different from the delta A/D conversion.

As explained above, in the transmission using delta A/D conversion, the transmitter differentiates a signal, quantizes the differentiated signal, and transmits the quantized signal, and the receiver integrates received signals and smoothes the integrated signal using a low pass filter to reproduce an original signal.

In contrast, as shown in Reference Diagram 10, in the transmission using noise-shaping A/D conversion, the transmitter integrates a signal, quantizes the integrated signal, differentiates the quantized signal, and transmits the differentiated signal. The receiver shapes the waveforms of a received signal using an inverter, and smoothes the shaped signal to reproduce an original signal.

Here, the noise shaping modulation at the transmitter shown in Reference Diagram 10 corresponds to a process recited in the first paragraph of Claim 1, a 1-bit conversion section recited in Claim 2. Moreover, an inverter, a resistor, and a capacitor at the receiver shown in Reference Diagram 10 correspond to a process recited in the last paragraph of Claim 1 and a drive section recited in Claim 8.

In this way, the transmission using noise-shaping A/D conversion requires no integrator at the receiver. Therefore, even if a DC offset is present in a signal input to the receiver, neither overflow nor underflow takes place since no integrators are provided in the receiver. As a result, even if the transmitter converts a signal into a non-return-to-zero signal having a narrow pulse width, it is not necessary for the receiver to expand the pulse width of a received signal. That is, the receiver requires no pulse expander. Therefore, it is possible to simplify the structure of the drive section recited in Claim 8 that does not include an integrator and a pulse expander. In these respects, the transmission using noise-shaping A/D conversion is superior to the transmission using delta A/D conversion.

Comparison of Applicants' Invention and Sulavuori

As can be understood from the comparison between Reference Diagram 2 and 10, the structures of a transmitter and a receiver in the conventional transmission using PCM-A/D conversion are quite different from those in the transmission using noise-shaping A/D conversion according to the present invention.

In addition, although Sulavuori superficially resembles the present invention in respect of combining a coder and a pulse shaper, advantageous effects obtained by the present invention in which a coder employs noise-shaping A/D conversion is significantly different from the effect obtained by Sulavuori in which a coder employs delta A/D conversion. Moreover, as can be understood from the comparison between Reference Diagrams 6 and 10, the structure of the receiver is quite different between Sulavuori and the present invention.

Based on the §103 rejections, it seems to the Applicant that the Examiner asserts that the invention as recited in independent claims 1 and 2 (hereinafter referred to as "the present invention") is rejected under 35 U.S.C. 102(b) as being anticipated by Sulavuori et al. because, for example, the DVSD of Sulavuori et al. is the same as the noise-shaping A/D conversion of the present invention.

However, as explained above in detail, the CVSD of Sulavuori et al. is different from the noise-shaping A/D conversion of the present invention. Therefore, the present invention is not anticipated by Sulavuori et al.

Furthermore, the present invention and Sulavuori are quite different in respect of effects obtained by narrowing the pulse width. Sulavuori allows data multiplexing by narrowing the pulse width (column 3, lines 31-47). In contrast, the present invention can suppress jitter which may be generated when a receiver shapes signal waveforms (page 10, second paragraph, of the original specification).

Specifically, the present invention employs the transmission using noise-shaping A/D conversion. Thus, even if the width of a pulse to be transmitted is narrowed, the receiver requires no pulse expander and integrator, and the receiver can reproduce an original signal by simply shaping the waveform of a received signal by an inverter, etc. Thus, narrowing the pulse width at the transmitter is quite effective to solve the problem in which noise is generated by a variation in the width of a pulse reproduced at the receiver that is caused by a variation in a threshold level (i.e., the averages shown in FIG 5 and 7) in the waveform shaping (page 5, line 16, through page 6, line 20, of the original specification).

In contrast, in the transmission using delta A/D conversion as employed in Sulavuori, since an integrator overflows if a signal whose waveform has been shaped by an inverter, etc., is directly input to the integrator, the receiver expands the duty ratio of a pulse of the signal to 100% and then integrates the expanded pulse. That is, the duty ratio of the pulse is always 100% regardless of the width of a pulse transmitted from the transmitter and a variation in width of a reproduced pulse due to a variation in a threshold level at the receiver. Therefore, in the transmission using delta A/D conversion as employed in Sulavuori, narrowing the width of a pulse is absolutely irrelevant to suppressing noise due to the jitter.

Moreover, the transmission using delta A/D conversion is quite different from the transmission using noise-shaping A/D conversion in respect of a driving scheme of a speaker.

In Sulavuori, transistors that form an operational amplifier, etc., used in the integrator at the receiver, operate in the saturated region, so that output impedance is generally high. As a result, it is impossible to drive a speaker having low input impedance. Thus, in order to drive such a speaker, it is necessary to provide an A-class power amplifier having low power efficiency that amplifies an output from the integrator.

In contrast, as explained above, in the transmission using noise-shaping A/D conversion as employed in the present invention, the receiver can reproduce the original signal at the transmitter based on signals obtained by, for example, shaping waveforms of a received signal using an inverter. Furthermore, transistors that form the inverter, etc., operate in the non-saturated region, so that output impedance is low. Thus, it is possible to directly drive a speaker having low input impedance using an output from the inverter, etc. This is a D-class operation that can realize excellent power efficiency.

In this manner, the circuit structure of the present invention in which the receiver requires neither a pulse expander nor an integrator and the advantageous effects obtained by such a structure are quire different from those in Sulavuori.

In view of these remarks, it is respectfully submitted that independent claims 1 and 2, and all dependent claims based thereon are allowable over the art of record. In addition, applicants' have amended independent claim 8 so that it is based on the data transmitting apparatus recited in claim 2. Therefore, it is respectfully submitted that independent claim 8 and all claims dependent thereon are now also in condition for allowance.

CONCLUSION

It is believed that all of the stated grounds of rejection have been properly traversed, accommodated, or rendered moot. Applicant therefore respectfully requests that the Examiner reconsider and withdraw all presently outstanding rejections. It is believed that a full and complete response has been made to the outstanding Office Action and the present application is in condition for allowance. Thus, prompt and favorable consideration of this amendment is respectfully requested. If the Examiner believes that personal communication will expedite prosecution of this application, the Examiner is invited to telephone the undersigned at (248) 641-1600.

Applicant believes no fee is due with this response. However, if a fee is due, please charge our Deposit Account No. 08-0750, under Order No. 5259-000031/US from which the undersigned is authorized to draw.

Dated:

Respectfully submitted,

By ____________________

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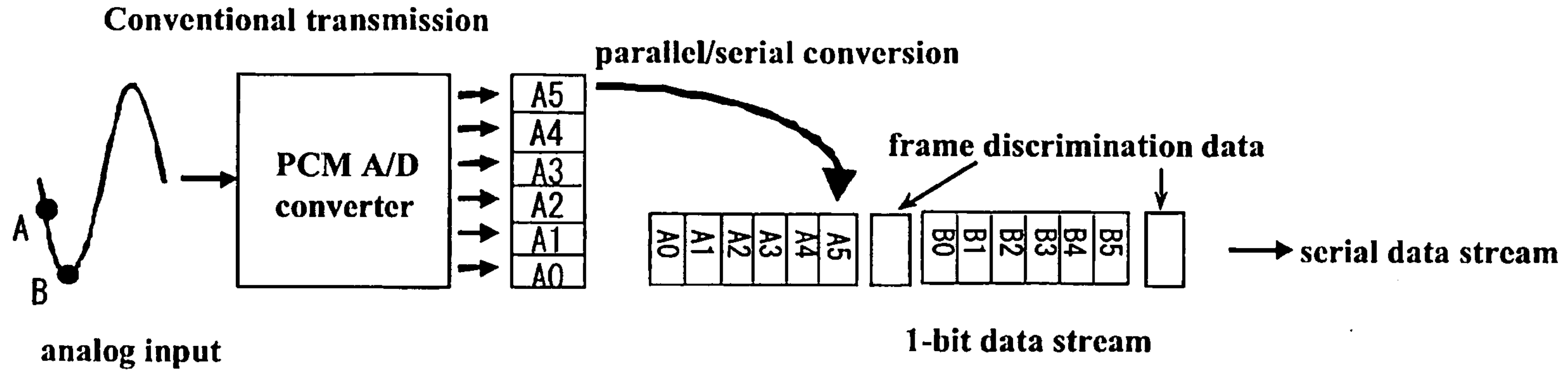
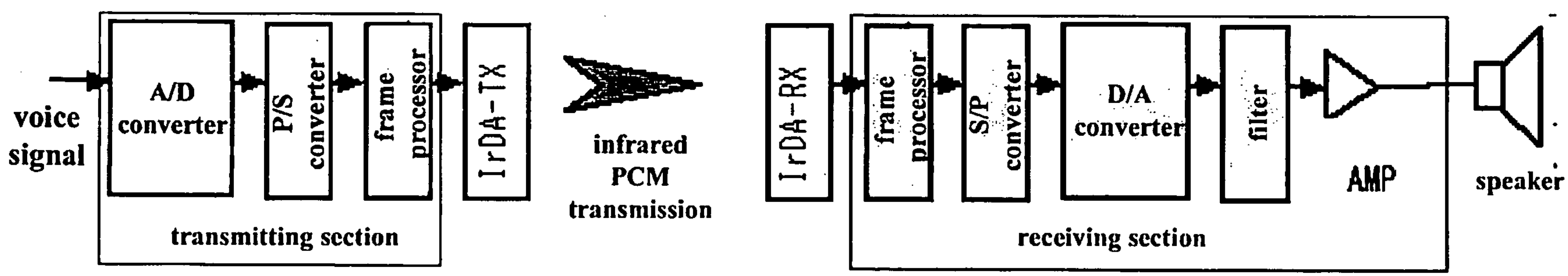
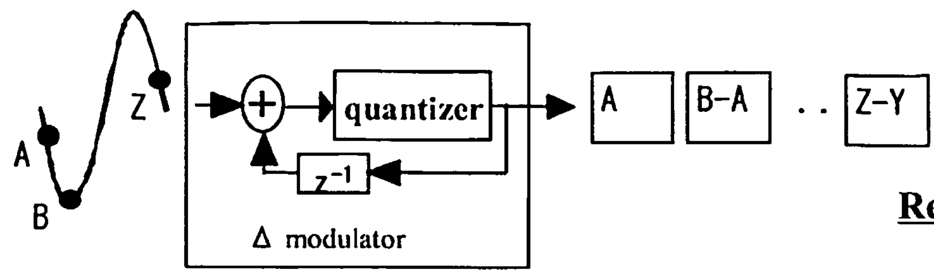
Attachments

Reference Diagram 1

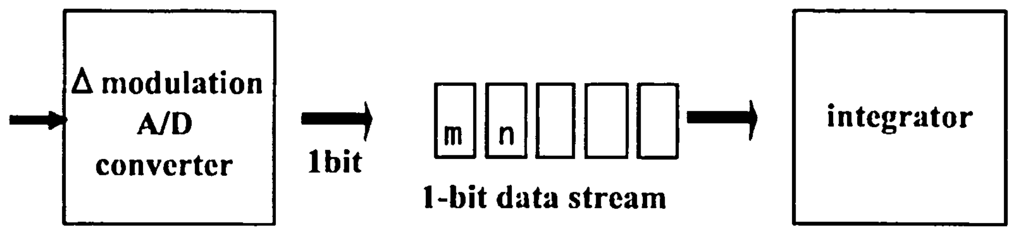


Reference Diagram 2



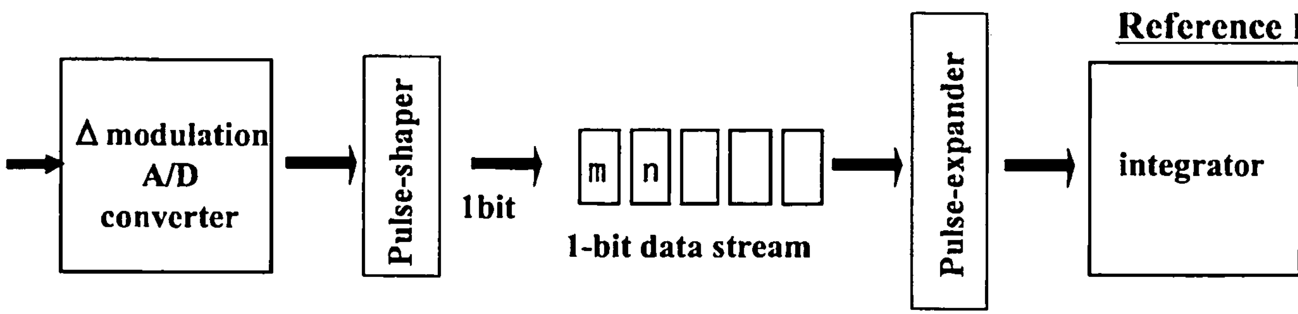


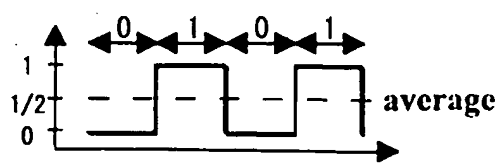
Reference Diagram 3



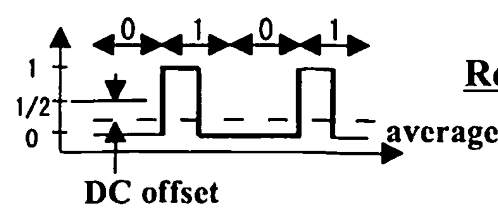
Reference Diagram 4

Reference Diagram 6



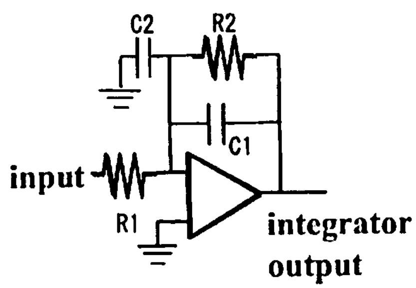


Reference Diagram 5

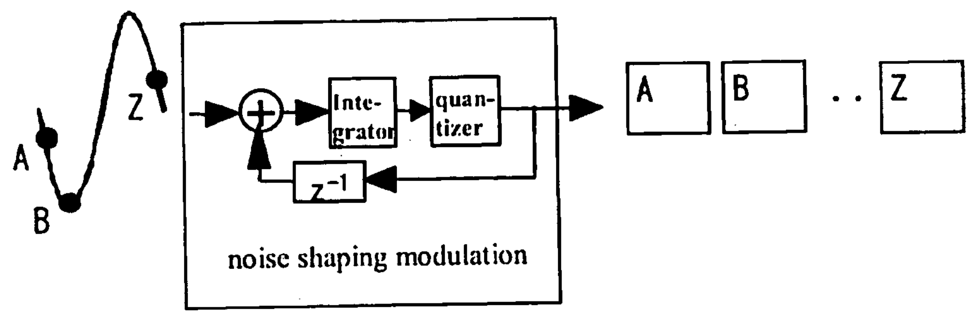


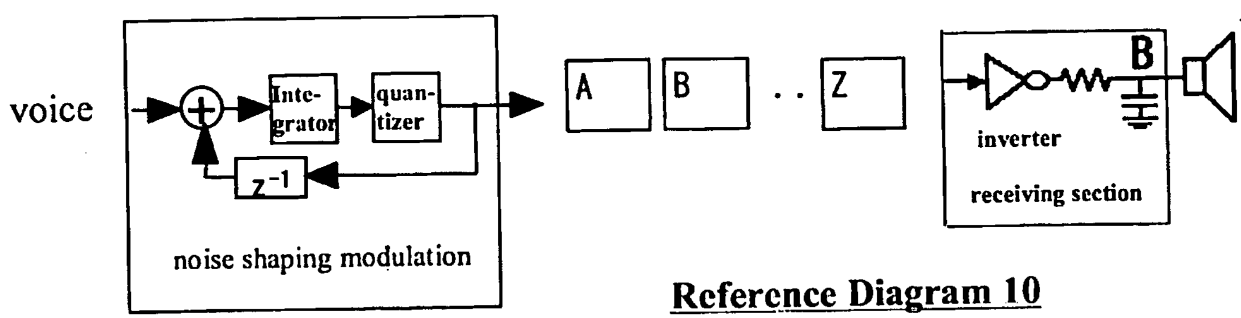
Reference Diagram 7

Reference Diagram 8



Reference Diagram 9





Reference Diagram 10